consumers substitute away from these goods and services which reduces the net effect of the price increase in the cost-plus sector on overall inflation. Finally, the calculation ignores second-order macroeconomic responses to the change in output prices through changes in government expenditure, interest rates and the money supply.

A summary of these calculations may be useful. Recall that we wish to increase Pacific Bell's price cap by 1.92 percent which represents the change in expenses due to the shift from cash to accrual accounting for OPEBs in 1993. Some of this increase will be accounted for by the change in inflation; the rest must be supplied through the Z-adjustment we are calculating. The increase in inflation due to FAS 106 is measured in two steps: (i) we calculate the effect of FAS 106 on the expenses of an average firm to be 1.10 percent, and (ii) we calculate the fraction of GNP produced by firms whose prices do not already reflect accrual accounting for OPEBs to be less than 10.49 percent. Since the incidence of OPEBs across industries is roughly constant, we estimate that the prices at which less than 10.49 percent of GNP is sold will increase by 1.10 percent, so that the increase in GNP-PI, averaged over all firms, will be less than 0.12 percent. Using this bound as an estimate, Pacific Bell's 1.92 percent price increase would thus consist of a 0.12 percent increase in GNP-PI and a 1.80 percent Z-adjustment. The required Z-adjustment (net of the change in GNP-PI) is thus at least 93.74 percent of the $29 million change in expenses, or at least $27 million.

These results are stable with respect to the various assumptions and forecasts that we have made. In Table 2, we summarize our previous results and provide new estimates assuming (i) a 100 percent increase in the effect of FAS 106 on an average

Table 2
Summary of Results
and
Sensitivity Analysis

	BASE CASE	NATIONAL FAS EFFECT IS 100% LARGER	COST-PLUS SECTOR IS 100% LARGER	PB REVENUE FORECAST IS 10% LARGER
PAC BELL FAS EFFECT	1.92%	1.92%	1.92%	1.74%
GNP-PI EFFECT	0.12%	0.23%	0.23%	0.12%
Z-ADJUSTMENT	1.80%	1.69%	1.69%	1.62%
% FAS IN GNP-PI	6.26%	12.01%	12.01%	6.89%
% FAS IN Z	93.74%	87.99%	87.99%	93.11%
Z	$26,808	$25,166	$25,166	$26,629

U.S. firm, (ii) a 100 percent increase in the cost-plus proportion of the U.S. economy, and (iii) a 10 percent increase in our forecast of Pacific Bell's 1993 revenues. Clearly, the results are insensitive to the assumptions.

APPENDIX

In this Appendix, we provide the details of the derivation of the price cap annual adjustment formula. The logic follows that of Dr. Schankerman, whose presentation of the price cap formula formed the basis of the California price cap plan.[43]

A. The Relationship Among TFP, Input Price, and Output Price Growth

Consider a multiproduct firm having N outputs (Q_i^o, i=1,...,N) and M inputs (Q_j^I, j=1,...,M). We wish to calculate X and Z so that in all periods, economic profits are identically zero, i.e., that the value of total inputs (including a normal return on capital) equals the value of total output. The identity can be written as

$$\sum_{i=1}^{N} p_i Q_i^o = \sum_{j=1}^{M} w_j Q_j^I ,$$

where p_i and w_j denote output and input prices respectively. Differentiating this identity with respect to time yields

$$\sum_{i=1}^{N} \dot{p}_i Q_i^o + \sum_{i=1}^{N} p_i \dot{Q}_i^o = \sum_{j=1}^{M} \dot{w}_j Q_j^I + \sum_{j=1}^{M} w_j \dot{Q}_j^I ,$$

[43] Testimony of Mark Schankerman on behalf of GTE California Incorporated, Docket I. 87-11-033, Technical Appendix, pp. 1-3.

where a dot indicates a derivative with respect to time. Dividing both sides of the equation by the value of output $R = \sum_i p_i Q_i^o$ or $C = \sum_j w_j Q_j^I$, we obtain

$$\sum \dot{p}_i \left(\frac{Q_i^o}{R} \right) + \sum \dot{Q}_i^o \left(\frac{p_i}{R} \right) = \sum \dot{w}_j \left(\frac{Q_j^I}{C} \right) + \sum \dot{Q}_j^I \left(\frac{w_j}{C} \right),$$

where R and C denote revenue and cost. If r_i denotes the revenue share of output i and c_j denotes the cost share of input j, then

$$\sum_i r_i \, dp_i = \sum_j c_j \, dw_j - \left[\sum_i r_i \, dQ_i^o - \sum_j c_j \, dQ_j^I \right],$$

where d denotes a percentage growth rate: $dp_i = \dot{p}_i / p_i$. The first term in the above equation is the revenue weighted average of the rates of growth of output prices, and the second is the cost-weighted average of the rates of growth of input prices. The term in brackets is the difference between the rates of growth of weighted averages of outputs and inputs and is thus the change in TFP. We can write the equation as

$$dp = dw - dTFP.$$

Thus the growth in input prices less the growth in output prices is equal to the change in TFP. This result requires only that excess profits are zero in every period. It does not require cost minimization, profit maximization, marginal cost pricing, or constant returns to scale.

B. The Price Cap Adjustment Equation

We begin with equation (3) from the text:

(6) $$dp = dp^N - [\, dTFP - dTFP^N + dw - dw^N \,] + [\, Z^* - Z^{*N} \,].$$

If we measure national output price inflation by the change in GNP-PI, we obtain

(7) $$dp = GNP\text{-}PI - X + Z'$$

where $X = [\, dTFP - dTFP^N \,] + [\, dw - dw^N \,]$ and $Z' = Z^* - Z^{*N}$. Since the percentage change in the regulated firm's output price between years t-1 and t is just $[P_t - P_{t-1}] / P_{t-1}$, we can write equation (7) as

$$\frac{P_t - P_{t-1}}{P_{t-1}} = GNP\text{-}PI - X + Z'$$

so

$$P_t - P_{t-1} = P_{t-1} \times [\, GNP\text{-}PI - X + Z' \,]$$

which simplifies to

(8) $$P_t = P_{t-1} \times [\, 1 + GNP\text{-}PI - X + Z' \,].$$

Since revenue equals price times quantity, the revenue change associated with the price change in equation (8) is obtained by multiplying both sides of the equation by the fixed amount of quantity demanded:

$$q_{t-1} \times P_t = q_{t-1} \times P_{t-1} \times [\, 1 + GNP\text{-}PI - X + Z' \,]$$

or

(9) $$R_t = R_{t-1} \times [\, 1 + GNP\text{-}PI - X \,] + Z$$

where Z represents the total dollar value of the exogenous cost change rather than the unit cost change.